

WE CLAIM:

1. A method of JPEG compression of an image frame divided
up into a plurality of non-overlapping, tiled 8×8 pixel blocks
5 B_{ij} where i, j are integers covering all of the blocks in the
image frame, comprising:

(a) forming a discrete cosine transform (DCT) of each
block B_{ij} of the image frame to produce a matrix of blocks of
transform coefficients D_{ij} ;

(b) calculating a visual importance, I_{ij} , for each
block of the image, based upon assigning zeros for flat features
and values approaching unity for sharply varying features;

(c) forming a global quantization matrix Q by one of

(i) selecting a standard JPEG quantization table
and

(ii) selecting a quantization table such that the
magnitude of each quantization matrix coefficient
 Q_{ij} is inversely proportional to the importance in
the image of the corresponding DCT basis vector;
and

(d) selecting a linear scaling factor S_{ij} defining
bounds over which the image is to be variably quantized;

(e) quantizing the transform coefficients, D_{ijmn} , by an equivalent of dividing them by a factor $S_{min} * Q$, where S_{min} is a user selected minimum scaling factor, and

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(f) entropy encoding quantized coefficients T_{ijmn} and $Q * S_{min}$ to create a JPEG image file.

2. A method according to claim 1, wherein step (e) includes rounding $(D_{ijmn} / (S_{min} * Q))$ to the nearest integer to form quantized DCT transformed coefficients T_{ijmn} ;

(a) setting $T_{ijmn} = 0$ if $\text{round}(D_{ijmn} / (Q_{mn} * S_{ij})) = 0$; and

(b) setting $T_{ijmn} = \text{sign}(D_{ijmn}) * (2^{(\text{ceil}(\lg(\text{abs}(D_{ijmn}) + 1)) - 1) - 1)$ if $\text{abs}(D_{ijmn}) - (2^{(\text{ceil}(\lg(\text{abs}(D_{ijmn}) + 1)) - 1) - 1)$ is less than or equal to $\text{abs}(D_{ijmn} - Q_{mn} S_{ij} * \text{round}(D_{ijmn} / (S_{ij} * Q_{mn})))$;

3. A method according to claim 1, including calculating a linear scaling factor S_{ij} equal to $I_{ij} * (S_{max} - S_{min}) + S_{min}$ where S_{min} and S_{max} are user specified to define bounds over which the image will be variably quantized.

4. The method according to claim 1, where I_{ij} is determined by discrete edge detection and summation of transform coefficients.

5. The method according to claim 1, wherein I_{ij} is determined by creating a 24 x 24 matrix of image pixels of DCT coefficients centered on a block B_{ij} , where i and $j = 1, 2, \dots, 8$, convolving said 24 x 24 matrix with an edge tracing kernel to produce a convolved matrix, summing center 10 x 10 matrix values of said convolved matrix to produce a summed value, and normalizing said summed value to produce a visual importance, I_{ij} .

6. The method according to claim 1, wherein said Q is formed by calculating an 8 x 8 matrix A by calculating matrix elements A_{mn} of said A according to the formula

$$A_{mn} = \sum_{(i,j)} I_{ij} (B_{ij})_{mn},$$

calculating elements Q_{mn} of said Q according to the formula

$$Q_{mn} = \max(A_{mn}) / A_{mn}$$

and scaling values of Q_{mn} for all values of (m,n) except $(0,0)$ in order to minimize an error between Q and a standard JPEG quantization matrix.

7. A method of JPEG compression of an image frame divided up into a plurality of non-overlapping, tiled 8 x 8 pixel blocks B_{ij} where i, j are integers covering all of the blocks in the image frame, comprising:

(a) forming a discrete cosine transform (DCT) of each block B_{ij} of the image frame to produce a matrix of blocks of transform coefficients D_{ij} ;

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(b) calculating a visual importance, I_{ij} , for each block of the image, based upon assigning zeros for flat features and values approaching unity for sharply varying features;

(c) forming a global quantization matrix Q by one of

(i) selecting a standard JPEG quantization table and

(ii) selecting a quantization table such that the magnitude of each quantization matrix coefficient Q_{ij} is inversely proportional to a visual importance, I_{ij} , to the image of a corresponding DCT basis vector; and

20 (d) selecting a linear scaling factor S_{ij} defining bounds over which the image is to be variably quantized wherein $S_{ij} = l_{ij}(S_{\max} - S_{\min}) + S_{\min}$, where S_{\max} and S_{\min} are user selected;

(e) quantizing the transform coefficients, D_{ijmn} , to
25 produce quantized blocks T_{ijmn} as follows:

(i) $T_{ijmn} = \text{round}(D_{ijmn}/(S_{\min} * Q_{mn}))$, where round denotes rounding to the nearest integer;

(ii) setting $T_{ijmn} = 0$ if $\text{round}(D_{ijmn}/(Q_{mn} * S_{ij})) = 0$;

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(iii) setting $T_{ijmn} =$
 $\text{sign}(D_{ijmn}) * (2^{(\text{ceil}(\lg(\text{abs}(D_{ijmn}))+1))-1}-1)$ if $\text{abs}(D_{ijmn}) -$
 $(2^{(\text{ceil}(\lg(\text{abs}(D_{ijmn}))+1))-1}-1)$ is less than or equal to $(\text{abs}(D_{ijmn}) -$
 $Q_{mn} * S_{ij} * \text{round}(D_{ijmn}/(S_{ij} * Q_{mn})))$;

(f) entropy encoding quantized coefficients T_{ijmn} and
 $Q * S_{\min}$, to create a JPEG image file.

8. A method of JPEG compression of a colour image
represented by channels Y for greyscale data, and U and V each
for colour, comprising:

(a) shrinking the colour channels U and V by a
fraction of their size;

(a) forming a discrete cosine transform (DCT) D_{ij} for
each block B_{ij} of each of channels Y, U and V;

(b) calculating a visual importance, I_{ij} , for each Y
channel block of each image and setting $I_{ij} = \max\{I_{ij} \text{ values for}$

corresponding Y channel blocks} for blocks in the U and V channels;

(c) forming a global quantization matrix Q for the Y channel block and one for channels U and V combined such that a magnitude of each quantization matrix coefficient Q_{ij} is inversely proportional to an importance in the image of a corresponding DCT basis vector; and

(d) quantizing the transform coefficients for each of the Y, U and V channels by dividing them by a factor $S_{ij} Q'$, where S_{ij} is a linear scaling factor for each of channels Y, U and V and Q' is the quantization table for the associated channel being quantized; and

(e) entropy encoding quantized coefficients T_{ijmn} and $Q' * S_{min}$, where S_{min} is a user selected minimum scaling factor for each of channels Y, U, and V, to create a JPEG image file for each of channels Y, U and V.

9. The method of claim 8 wherein the shrinking factor is $1/2$.

10. Apparatus for JPEG compression of an image frame divided up into a plurality of non-overlapping, tiled 8×8 pixel blocks B_{ij} , where i, j are integers covering all of the blocks in the image frame, comprising:

(a) a discrete cosine transformer (DCT) operative to form the deiscrete cosine transform of each block B_{ij} of the image frame to produce a matrix of blocks of transform coefficients D_{ij} ;

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(b) a visual importance calculator operative to calculate the visual importance, I_{ij} , for each block of the image, based upon assigning zeros for flat features and values approaching unity for sharply varying features;

(c) a global quantization matrix calculator operative to calculate the global quantization matrix, Q , by one of

(i) selecting a standard JPEG quantization table and

(ii) selecting a quantization table such that the magnitude of each quantization matrix coefficient Q_{ij} is inversely proportional to the importance in the image of the corresponding DCT basis vector;

and

(d) a linear scaling factor calculator operative to determine a linear scaling factor, S_{ij} , defining bounds over which the image is to be variably quantized based on user established values of S_{\max} and S_{\min} ;

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(e) a quantizer operative to divide the transform coefficients, D_{ijmn} , by a value equivalent to dividing them by a factor $S_{min} * Q$, where S_{min} is a user selected minimum scaling factor, and

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(f) an entropy encoder operative to encode the quantized coefficients T_{ijmn} and $Q * S_{min}$ to create a JPEG image file.

11. Apparatus according to claim 10, wherein said quantizer rounds $(D_{ijmn} / (S_{min} * Q))$ to the nearest integer to form quantized DCT transformed coefficients T_{ijmn} and

(a) sets $T_{ijmn} = 0$ if $\text{round}(D_{ijmn} / (Q_{mn} * S_{ij})) = 0$; and

(b) sets $T_{ijmn} = \text{sign}(D_{ijmn}) * (2^{(\text{ceil}(\lg(\text{abs}(D_{ijmn}) + 1)) - 1) - 1}$ if $\text{abs}(D_{ijmn}) - (2^{(\text{ceil}(\lg(\text{abs}(D_{ijmn}) + 1)) - 1) - 1}$ is less than or equal to $\text{abs}(D_{ijmn} - Q_{mn} S_{ij} * \text{round}(D_{ijmn} / (S_{ij} * Q_{mn})))$;

12. Apparatus according to claim 10, wherein said linear scaling factor calculator determines a linear scaling factor S_{ij} equal to $I_{ij} * (S_{max} - S_{min}) + S_{min}$ where S_{min} and S_{max} are user specified to define bounds over which the image will be variably quantized.

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